

Optimizing Energy Use in Broiler Houses

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Introduction:

Optimizing energy use in broiler houses requires using energy to maximize profits, not necessarily, bird performance. This is an important distinction since many growers, in their quest to produce the biggest birds, may lose sight of the fact that the return on investment, in terms of every additional dollar spent on energy, will not continue to increase. Donald et al. (2001) reported that propane accounted for 40% of the grower's out-of-pocket expenses; electricity accounts for another 10%. Hence, there is opportunity for the grower to optimize energy use to maximize his/her profits. In this paper, energy optimization practices are broadly categorized into (i) reducing energy loss and (ii) improving ventilation. Both these categories work in synergy to improve the grower's bottom line and should be treated as profit centers and not as cost centers.

Reducing energy loss:

Energy conservation practices in broiler houses range from simple, routine maintenance type to major retrofitting. The first question the grower should ask himself/herself is whether his/her house is tight, i.e., has the fewest possible leaks. Determine this by shutting off all doors and inlets and turning on one 48 in. fan. In a new tight house, especially, with solid walls, you can get static pressure as high as 0.33 in. while in an older, though tight house, you could get 0.25 in. A lower value of static pressure indicates a looser house. Using smoke tests, the leakage points should be identified and sealed shut. Simpson and Donald (2005) reported that tightening up two broiler houses (more than 25 years old) resulted in static pressure increasing from 0.03 in. to 0.16 in.

The tightening practices included applying spray foam to sidewall, end wall and ridge cracks; weather stripping doors and sealing unused openings; and installing curtain flaps and boots. These upfits reduced energy use by 30% and improved cooling during the summer resulting in better settlements. Hence, the return on investment in caulk and spray foam is very rapid.

After a house has been tightened, a grower should see if energy losses can be reduced by increasing insulation. In the southeastern US, ceiling, sidewalls and endwalls, and doors (also roll-up doors) should be have R values of 19, 8 to 11, and 5 to 8, respectively. When new, a house may have been adequately insulated; however, with passage of time, blown insulation in the ceiling can settle or shift, resulting in bare spots that can cause

heat loss. Use of tunnel ventilation causes more vibration in the ceiling resulting in more rapid sliding down of the blown insulation (cellulose). These 'bare' spots will have heavy condensation. A photograph with a thermal imaging camera can be used for identifying these cold spots on the ceiling as well as on the walls (Figure 1). Installing 1 in. by 4 in. 'dams' between trusses or laying down fiberglass batts will prevent insulation from shifting and causing heat losses.

Many older houses have poorly insulated ceilings. A 40 by 500 ft open ceiling house will need 5 gallons/hour more propane in the brood chamber than a house of the same size with drop ceiling with R 19 insulation when the outside temperature is 40 F and the inside temperature is kept at 85 F. By cutting down the heat load during the summer, this insulation will substantially reduce electricity use and improve bird performance.

Converting curtain sides to solid walls by spraying 1.5 in. of closed cell foam insulation to increase the R value of the curtain from 1 to 11 will also reduce energy losses. Cost of converting a curtain side to solid wall using closed cell foam insulation with an R value of 7-8 may cost about \$1/sq. ft. (M. Czarick, Univ. of Georgia, personal communication). If a failsafe, backup power supply is not available or airing out the houses is a concern, consider converting only the north side to solid wall since the south side sees the sun during winter but very little during the summer. Insulating end walls to R 11 will also help conserve energy. Using a double layer of brood curtains with an air pocket in between will also reduce heating losses since its R value could be about 4-5 (depending on the depth of the air pocket) compared with 1 for a single curtain. During winter, some growers cover their unused fans with foam boards (R value of 4-5). These foam boards not only conserve heat inside the house but also prevent back-drafting of cold air.

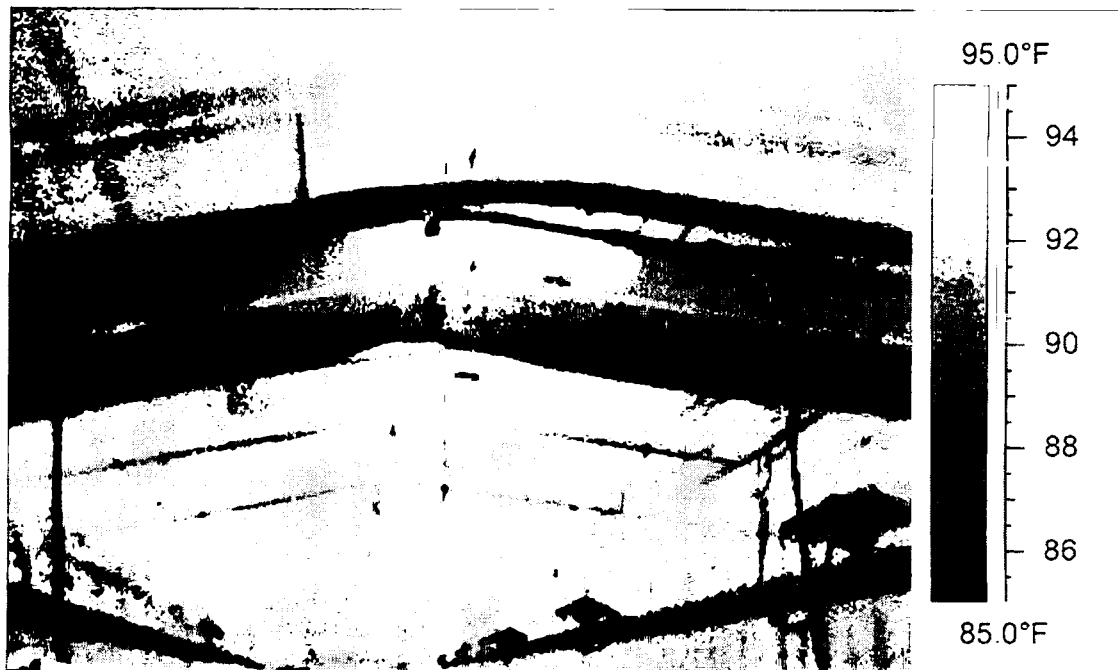


Figure 1. An infrared view of a broiler house showing heat loss at the ceiling ridge due to displaced insulation (Courtesy: M. Czarick, Univ. of Georgia)

Fairchild (2005) reported that the floor temperature should be 90 F when chicks are introduced into the house. Forced air furnaces, pancake brooders, and radiant brooders (including the tube type) can preheat the litter to the desired temperature. However, unlike the radiant brooder (and to a lesser extent, the pancake brooder), the forced air furnace heats the air and not the litter. Since hot air rises to the ceiling, a forced air furnace runs longer (and burns more energy) than the brooders to heat the floor to the desired temperature. Consequently, the floor to ceiling temperature difference could be 15 to 20 F (Figure 2). Czarick and Lacy (2000) reported that by better mixing the air in the house using two 18 in. direct drive circulation fans in the brood chamber, the floor temperature was increased by 5 F while propane cost was reduced by 30%. Flood et al. (1998) reported that using ceiling fans to better mix air in brood chambers resulted in reduced total energy use by 8%. Using ceiling fans in the updraft mode can ensure good thermal mixing and reduce energy use in brooding, particularly, with forced air furnaces. While brooders show lower temperature stratification than forced air furnaces, even with radiant brooders, floor to ceiling temperature differences of 5 F occur. Hence, fans can still save energy when used in conjunction with the radiant and pancake brooders. In summary, radiant brooders will reduce energy use (by 15-30%) over pancake brooders, while forced air furnaces consume more energy than the brooders.

Radiant tube heaters may offer another option for reducing energy use in broiler houses. These heaters are likely to reduce energy use vs. pancake brooders and forced air furnaces. However, in the absence of side-by-side scientific studies, it is unclear if they offer a clear economic advantage over radiant brooders. Being located much higher above the floor than radiant brooders, the tube heaters do not have to be raised or lowered. Further, compared to the radiant brooder, a radiant tube heater spreads more of the warmth to the sidewalls and reduces the hot spot directly beneath the brooder (Donald et al., 2003). Having fewer heaters (vs. radiant brooders) also reduces maintenance. Very importantly, radiant tube heaters can preheat broiler houses much faster than radiant brooders, saving energy (Czarick, 2005). However, in drop ceiling houses, manufacturer's instructions on shielding and clearances should be strictly followed to protect the vapor barrier, electrical wires, and fogger lines. Lowering the height of the radiant tube heater will reduce the width of the house floor that will be heated, with higher temperatures directly beneath the heater. Growers are encouraged to read the article by Czarick (2005) for more on radiant tube heater floor heating patterns.

Improving ventilation:

A proper ventilation system brings in the correct amount of fresh air through the planned inlets, mixes the fresh and exhaust air streams to warm up the fresh air (only for minimum ventilation), and exhausts the right amount of stale air. Hence, the ventilation system not only helps maintain the proper air quality in the house but also more uniform temperature and humidity regimes that benefit the birds.



Figure 2. An infrared view of a broiler house showing temperature stratification (Courtesy: M. Czarick, Univ. of Georgia)

A major deficiency in the ventilation system affecting productivity is inadequate tension in the belts in belt-driven fans. Because worn belts ride lower in their pulleys and also slip more, they can reduce the fan airflow rates by 30%; hence, running a single 1.5 hp 48 in. fan 30% more to compensate for loose belts will cost you an extra \$55 per year (at \$0.055/unit for 3900 vs. 3000 hours/year). Growers are conscientious about tightening their fan belts each layout but it is time consuming. (I read a label on a broiler house fan that said that the fan belt should be tightened after 3 days of operation!). Twist-lock belts are very popular with poultry growers because they are relatively inexpensive and can be adjusted by adding or removing a link; however, it is unclear if they save the growers much money. The much thinner twist-lock belt cannot grip the sides of the v-pulleys as well as the v-belts; hence, even if it is tensioned per supplier specifications, the twist-lock belt will cause the fan to run slower than a properly maintained v-belt. A self tensioning system that uses a combination of the motor weight and spring action, when combined with a v-belt, will save a lot of money and time over the long run. If a retrofit self-tensioning kit is unavailable, an adjustable tensioner (that would have to be adjusted periodically) with a v-belt would still be a reasonable compromise. It is also important to make sure that the v-pulleys are properly aligned with one-another, otherwise, belt wear will be high and airflow rate will be reduced.

Dust accumulation on fan shutters and guards can also considerably reduce airflow rates, either reducing ventilation, increasing energy use, or both. Donald (200x) reported that a 36 in fan at 0.05 in. static pressure with clean shutter had an airflow rate of 8,519 cfm compared with 6.617 cfm with dirty shutter. Hence, it is important to keep shutters and guards clean. Cool cell pads and inlets should also be kept clean.

A 36 in. fan requires 7-8 inlets while a 48 in. fan requires 15-16 inlets. Sidewall inlets should open 1.5 to 2 in. while ceiling inlets should open 1 to 1.5 in.; when inlets open the correct width, fresh air is thrown at 800-1,000 ft/min into the middle of the house where it properly mixes with the warm rising air, transferring some of the heat down to the birds. When inlets do not open enough, static pressure is increased and the fans are choked down while inlets that open wider than desired, cause the cold air to trickle down to the floor causing wet spots on the litter. Hence, proper operation of the inlets (sidewall or ceiling) for minimum or mild weather ventilation is also important.

References

- Czarick, M. 2005. Radiant tube heater floor heating patterns. Poultry Housing Tips 17(5). Cooperative Extension Service, Univ. of Georgia, Athens, GA.
- Czarick, M. and M. Lacy. 2000. Reducing temperature stratification in houses with forced air furnaces. Poultry Housing Tips 12(4). Cooperative Extension Service, Univ. of Georgia, Athens, GA.
- Donald, J. 200x. Value of clean shutters proven in laboratory test. Fact sheet. Alabama Cooperative Extension Service, Auburn Univ., AL.
- Donald, J., M. Eckman, and G. Simpson. 2001. Paddle and circulating fans - a progress report. The Alabama Poultry Engineering and Economics Newsletter No. 13 (Sept.). Alabama Cooperative Extension Service, Auburn Univ., AL.
- Donald, J., M. Eckman, and G. Simpson. 2003. Radiant tube heating - questions and answers. The Alabama Poultry Engineering and Economics Newsletter No. 26 (Nov.). Alabama Cooperative Extension Service, Auburn Univ., AL.
- Fairchild, B. 2005. Environmental factors to control when brooding chicks. Factsheet (July). Cooperative Extension Service, Univ. of Georgia, Athens, GA.
- Flood, C.A., J.L. Koon, R.D. Turnbull, and R.N. Brewer. 1998. Energy savings with ceiling fans in broiler houses. Appl. Eng. Agric. 14(3):305-09.
- Simpson, G. and J. Donald. 2005. Energy solutions for poultry producers. Alabama Agricultural Energy Conference.
(<http://www.adeca.state.al.us/C0/Agriculture%20Energy%20Efficiency/>)